

## P E T I T I O N

To the Commissioner of Patents and Trademarks  
Washington, D.C. 20231

Your Petitioners, JEFFREY O. WILLIS and ANTHONY J. HANSEN, citizens of the United States and residents of the State of Nebraska, whose post office addresses are 141 North 21st Street, Blair, Nebraska 68008, and 21411 Ridgewood Road, Elkhorn, Nebraska 68022, respectively, pray that Letters Patent may be granted to them for the improvement in

### METHOD AND MEANS FOR MOUNTING A WIND TURBINE ON A TOWER

as set forth in the following specification.

#### CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation application of Petitioners' earlier application Serial No. 09/563,612 filed May 2, 2000, entitled "METHOD AND MEANS FOR MOUNTING A WIND TURBINE ON A TOWER".

#### BACKGROUND OF THE INVENTION

##### 1. FIELD OF THE INVENTION

This invention relates to a method and means for mounting a wind turbine on the upper end of a supporting tower and more particularly to a method and means wherein the turbine is winched up the length of the tower on a carriage which rolls along a track or guide rail positioned at one side of the tower.

##### 2. DESCRIPTION OF THE RELATED ART

Wind turbines are becoming more popular in the production of electrical energy. The wind turbine normally comprises a rotor-driven generator mounted atop a tower which may reach heights of 70 meters or more. The tower is normally first erected and the wind turbine is then normally mounted on the upper end of the tower by means of an

1 extremely large crane. The customary method of mounting the wind turbine on the  
upper end of the tower is quite expensive in that the extremely large crane used for  
positioning the wind turbine on the tower is very expensive and it is costly to have such  
a crane on site during the erection procedure. Thus, it is advantageous to be able to  
5 mount the wind turbine on the upper end of the tower without the use of the extremely  
large crane.

### SUMMARY OF THE INVENTION

The wind turbine assembly of this invention comprises a vertically disposed tower  
having upper and lower ends with the tower having a guide rail means positioned at one  
side of the tower which extends between the lower and upper ends thereof. A turbine  
10 support or carriage is provided which has a pivotal platform mounted thereon adapted to  
have the wind turbine mounted thereon. The carriage is initially supported on a wheeled  
frame means such as a truck, trailer or the like. The truck is positioned so that the  
carriage may be transferred from the truck to the lower end of the guide rail means.  
The carriage is initially positioned on the lower end of the guide rail in a vertically  
15 disposed position. Once the carriage has been mounted on the lower end of the guide  
rail, the platform of the carriage is pivotally moved to a horizontally disposed position to  
enable the turbine to be mounted thereon with the turbine being generally horizontally  
disposed. After the turbine has been secured to the platform, the platform is pivoted so  
that the wind turbine is substantially vertically disposed with the main shaft (rotor shaft)  
20 thereof being positioned at the upper portion of the wind turbine. The spinner/hub and  
rotor blades are then secured to the main shaft with the rotor blades being disposed in a  
horizontally disposed condition. A winch means then winches the carriage, with the  
wind turbine thereon, to the upper end of the tower. When the carriage reaches the  
upper end of the tower, the platform is again pivoted to cause the wind turbine to be

1 again disposed in a substantially horizontally disposed position. The wind turbine is  
then slidably moved horizontally onto the upper end of the tower at which time the wind  
turbine is detached from the platform sled and is securely fashioned to the upper end of  
the tower. The carriage is then lowered to the lower end of the tower and is removed  
5 from the guide rails and placed onto the truck so that the carriage may be used for the  
erection of other wind turbine assemblies. An alternative method is also disclosed.

In the alternative method, the carriage is initially supported on a wheeled frame  
means such as a truck, trailer or the like as in the previously described method. The  
truck is positioned so that the carriage may be transferred from the truck to the lower  
10 end of the guide rail means. The carriage is initially positioned on the lower end of the  
guide rail in a vertically disposed position. Once the carriage has been mounted on the  
lower end of the guide rail, the platform of the carriage is pivotally moved to a  
horizontally disposed position to enable the turbine to be mounted thereon with the  
turbine being generally horizontally disposed and with the turbine being positioned so  
15 that the main shaft of the turbine extends towards one side of the tower. After the  
turbine has been secured to the platform, the carriage is winched upwardly on the tower  
a distance greater than the rotor-swept area. The spinner/hub and rotor blades are then  
secured to the main shaft with the rotor blades being disposed in a vertically disposed  
condition. The winch means then winches the carriage, with the wind turbine thereon,  
20 to the upper end of the tower. When the carriage reaches the upper end of the tower,  
the wind turbine is then slidably moved horizontally onto the upper end of the tower at  
which time the wind turbine is detached from the platform sled and is securely fashioned  
to the upper end of the tower. The carriage is then lowered to the lower end of the  
tower and is removed from the guide rails and placed onto the truck so that the carriage  
25 may be used for the erection of other wind turbine assemblies. In the alternative

method, the wind turbine always remains in a horizontally disposed position, thereby eliminating any problems with liquids draining from the gearbox, generator, etc.

It is a principal object of the invention to provide an improved method of erecting a wind turbine assembly.

A further object of the invention is to provide a method of positioning a wind turbine on the upper end of a wind turbine tower wherein the need of an extremely large crane is eliminated.

Still another object of the invention is to provide a wind turbine assembly wherein the turbine tower has a guide rail at one side thereof to accommodate a carriage to be vertically moved upwardly thereon with the carriage supporting the wind turbine.

Still another object of the invention is to provide an improved method and means for erecting a wind turbine assembly which is less dangerous than the prior art methods of erecting the same.

A further object of the invention is to provide an improved tower for wind turbines.

These and other objects will be apparent to those skilled in the art.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of the wind turbine assembly of this invention;

Figure 2 is a side view of the wind turbine assembly of Figure 1 as seen from the right of Figure 1;

Figure 3A is a side view of the tower and illustrating the carriage supporting the wind turbine being supported on a trailer at the lower end of the tower;

Figure 3B is a somewhat enlarged partial view of Figure 3A;

Figure 4 is a view similar to Figure 3B except that the carriage is being moved from the trailer to the guide rail;

1           Figure 5 is a view similar to Figure 4 except that the carriage has been completely removed from the trailer and has been mounted on the carriage;

          Figure 6 is a view similar to Figure 5 except that the platform of the carriage is being pivoted to a horizontal position;

5           Figure 7 is a view similar to Figure 6 except that the platform of the carriage has been pivoted to a horizontal position and the wind turbine is being lowered towards the platform;

          Figure 8 is a view similar to Figure 7 except that it illustrates the turbine positioned on the platform of the carriage;

10          Figure 9 is a view similar to Figure 8 except that it illustrates the carriage platform and the turbine being moved to a vertically disposed position;

          Figure 10 is a view similar to Figure 9 except that the carriage platform and wind turbine have been moved to a vertically disposed position;

15          Figure 11 is a view similar to Figure 10 but which illustrates the spinner/hub and rotors being lowered towards the wind turbine;

          Figure 12 is a view similar to Figure 11 except that the spinner/hub and rotor blades have been mounted on the wind turbine;

          Figure 13 is a view scene on lines 13-13 of Figure 12;

20          Figure 14 is a side view illustrating the carriage and wind turbine having been moved to the upper end of the tower;

          Figure 15 is a view similar to Figure 14 except that the carriage platform is being pivoted from its vertically disposed position to its horizontal position;

          Figure 16 is a view similar to Figure 15 except that the carriage platform and turbine have been moved to a horizontally disposed position;

Figure 17 is a view similar to Figure 16 except that the turbine is illustrated as having been slidably moved from the carriage platform to the upper end of the tower;

Figure 18 is a view similar to Figure 17 except that the carriage platform is illustrated as being pivotally moved towards a vertically disposed position;

Figure 19 is a view similar to Figure 18 except that the carriage is illustrated as being lowered towards the ground;

Figure 20 is a view similar to Figure 19 except that the carriage is being illustrated as being moved onto the trailer;

Figure 21 is a partial side view illustrating the connection of the winch means with the carriage while the carriage is mounted on a trailer;

Figure 22 is a sectional view illustrating the relationship of the tower, guide rail means and carriage;

Figure 23 is a partial side view illustrating the carriage platform in a vertically disposed position; and

Figure 24 is a partial side view illustrating the carriage platform having been moved to the upper end of the tower with the broken lines illustrating the movement of a portion of the carriage platform towards the upper end of the tower.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

The wind turbine assembly of this invention is referred to generally by the reference numeral 10 and includes a tower 12 which may have a height of up to seventy meters or more. A support structure 14 is in the form of a battered leg structure 14A and 14B is provided at one side of the tower 12 for stability purposes. Legs 14A and 14B are connected to the tower 12 by braces 15. The numeral 16 refers to a conventional wind turbine including a housing 18 which houses various components of the wind turbine 16 such as a cooling system, generator, gearbox, and a main shaft

1 extending therefrom onto which a spinner/hub 20 is mounted including rotor blades 22.  
The wind turbine 16 includes a conventional base portion 24 which is secured to the  
upper end of the tower 12. To this point, the wind turbine assembly 10 is generally of  
conventional prior art construction except for the battered leg structure which stabilizes  
the tower 12, distributes the load on the tower 12, and enables the tower 12 to be  
5 constructed of a lighter weight material.

The tower 12 is provided with a guide rail means 26 which in this case comprises  
a pair of vertically disposed and horizontally spaced guide rails 28 and 30 positioned at  
one side of the tower 12 with the guide rails 28 and 30 extending between the lower and  
upper ends of the tower 12. Although it is preferred that a pair of guide rails 28 and 30  
10 be provided, it is possible that any number of guide rails could be provided, if desired.  
Further, the guide rails 28 and 30 could be positioned on the opposite sides of the tower  
12 and could take shapes other than that disclosed. For example, guide rails could be  
T-shaped if desired.

The numeral 32 refers generally to a carriage which is adapted to move along the  
15 guide rails 28 and 30 and which includes a platform 52 adapted to have the wind turbine  
16 secured thereto and which includes means for pivoting the platform 52 approximately  
ninety degrees with respect to the carriage, as will be described in more detail  
hereinafter. It is preferred that the carriage 32 be removably positioned on a wheeled  
frame such as a truck or trailer 36 having a pair of spaced-apart guide rails 38 provided  
20 thereon which are adapted to mate with or register with the lower ends of the guide rails  
28 and 30 so that the carriage 32 may be moved from its position on the wheeled frame  
means 36 onto the guide rails 28 and 30.

Carriage 32 includes a pair of projecting frame members 40 and 42 having  
recessed portions 44 and 46 formed therein, respectively, which are adapted to receive  
25



1 the guide rails 28 and 30 and which are also adapted to receive the guide rails 38 when  
the carriage 32 is mounted on the wheeled frame means 36. It is preferred that the  
recessed areas 44 and 46 be provided with a plurality of slides or rollers 48 provided  
thereon to facilitate the sliding movement of the carriage 32 with respect to the guide  
rails 28 and 30. Generally speaking, carriage 32 includes a frame means 50 having the  
5 platform 52 pivotally secured thereto and which is movable therewith by means of  
power cylinder 54 or some other mechanism. It is preferred that a slide mechanism 56  
be slidably mounted on platform 52 to enable the slide mechanism 56 to be moved from  
the position illustrated in Figure 24 to a position towards tower 12 to enable the turbine  
16 to be moved from the carriage to the upper end of the tower 12 as will be more fully  
10 described hereinafter. Slide 56 includes means for having the wind turbine 16  
selectively secured thereto.

The numeral 58 refers to a winch which is preferably positioned at the lower end  
of the tower 12 and which has a winch cable 60 extending therefrom. Winch cable 60  
preferably extends around pulley 62 and thence upwardly to the upper end of the tower  
15 12 wherein it extends over pulleys 64 and 66. Winch cable 60 then extends  
downwardly, as seen in Figure 21, for connection to the carriage 32.

The tower 12 is first erected in conventional fashion, except for the structure 14,  
with the guide rails 28 and 30 being provided thereon as previously described. When it  
is desired to mount the turbine 16 on the upper end of the tower 12, the wheeled frame  
20 means 36 is positioned adjacent the lower end of the tower 12 so that the guide rails 38  
mate with the lower ends of the guide rails 28 and 30. The winch cable 60 is then  
connected to the carriage 32 and the winch 58 is actuated so that the cable 60 pulls the  
carriage 32 from the wheeled frame means 32 onto the lower ends of the guide rails 28  
and 30, as illustrated in Figures 4 and 5. When the carriage 32 has been positioned on  
25



1 the lower end of the guide rails 28 and 30, as illustrated in Figure 5, the platform 52 is  
pivotally moved from the vertically disposed position of Figure 5 to the position of Figure  
6 and then to the position of Figure 7. At that time, the wheeled frame means 36 may  
5 be moved away from the lower end of the tower 12. When the platform 52 is in the  
position of Figure 5, a small crane is then used to lower the wind turbine 16 onto the  
slide 56 to which it is securely fastened, as illustrated in Figure 8. The platform 52 is  
then pivotally moved from the position of Figure 8 to the position of Figure 9 and then to  
the position of Figure 10 wherein the wind turbine 16 is substantially vertically disposed.  
10 When the wind turbine 16 is in the position of Figures 10 and 11, the spinner/hub 20  
with the rotor blades 22 attached thereto is lowered onto the main shaft of the wind  
turbine 16 by means of a small crane or the like. It should be noted that the rotor blades  
22 may be secured to the spinner/hub 20 after the spinner/hub 20 has been mounted on  
the wind turbine 16. Figure 12 illustrates the spinner/hub 20 and the rotor blades 22  
15 mounted on the wind turbine 16. Figure 13 is a top view illustrating the wind turbine 16  
in the position of Figure 12.

20 When the spinner/hub 20 and rotor blades 22 have been mounted on the wind  
turbine 16, the carriage 32 with the wind turbine 16 mounted thereon is winched to the  
upper end of the tower 12 by means of the winch 58. When the carriage 32 has been  
winched to the position of Figure 14, the platform 52 is pivotally moved from its vertically  
disposed position to the position of Figure 15 and then to the position of Figure 16. The  
25 slide 56 is then moved towards the upper end of the tower 24, as indicated by the  
dashed arrow in Figure 24, so that the wind turbine 16 may be removed from the slide  
56 and secured to the upper end of the tower 24. When the turbine 16 has been  
secured to the upper end of the tower 12, as illustrated in Figure 18, the platform 52 is  
pivotally moved from its horizontally disposed position to the position of Figure 18 and

1 then to a vertically disposed position. The carriage 32 is then lowered on the guide rails  
28 and 30 to the lower end of the tower. The wheeled frame means 36 is then  
positioned adjacent the lower end of the tower so that the guide rails 38 thereof register  
once again with the guide rails 28 and 30. The carriage 32 is then moved from the  
5 guide rails 28 and 30 onto the guide rails 38 of the wheeled frame means 36 so that the  
carriage 32 is positioned on the wheeled frame means 36. The wheeled frame means  
36 and the carriage 32 may then be moved to another location wherein another wind  
turbine assembly 10 is to be erected.

10 The turbine 16 may be installed or mounted on the upper end of the tower in a  
somewhat different way such as will now be described. As in the previously described  
method, when it is desired to mount the turbine 16 on the upper end of the tower 12, the  
wheeled frame means 36 is positioned adjacent the lower end of the tower 12 so that  
the guide rails 38 mate with the lower ends of the guide rails 28 and 30. The winch  
15 cable 60 is then connected to the carriage 32 and the winch 58 is actuated so that the  
cable 60 pulls the carriage 32 from the wheeled frame means 36 onto the lower ends of  
the guide rails 28 and 30. When the carriage 32 has been positioned on the lower end  
of the guide rails 28 and 30, the platform 52 is pivotally moved from the vertically  
disposed position of Figure 5 to the position of Figure 6 and then to the position of  
Figure 7. At that time, the wheeled frame means 36 may be moved away from the  
lower end of the tower 12. When the platform 52 is in the position of Figure 5, the  
20 carriage 32 is then winched upwardly along the guide rails 28 and 30 until the carriage  
has reached a height which is greater than the rotor-swept area. The wind turbine 16 is  
then positioned on the platform 52 of the carriage 32 by means of a small crane with the  
wind turbine 16 being horizontally disposed and with the main shaft thereof extending  
laterally from one side of the tower. The spinner/hub 20 with the rotor blades 22

attached thereto are then secured to the main shaft of the wind turbine 16 with the rotor blades being vertically disposed.

When the spinner/hub 20 and the rotor blades 22 have been mounted on the wind turbine 16, the carriage 32 with the wind turbine 16 mounted thereon is winched to the upper end of the tower 12 by means of the winch 58. When the carriage 32 has been winched to the upper end of the tower, the slide 56 is then moved towards the upper end of the tower 24 so that the wind turbine 16 may be removed from the slide 56 and secured to the upper end of the tower 24. When the turbine 16 has been secured to the upper end of the tower 12, the carriage 32 is then lowered on the guide rails 28 and 30 to the lower end of the tower, as in the previously described method.

The advantage of the alternate method is that the wind turbine is always in a horizontally disposed position. In some cases, if the wind turbine was vertically disposed and components of the turbine have been previously filled with lubricating fluids, cooling fluids, etc., some leakage could possibly occur. By maintaining the wind turbine in the horizontally disposed condition, leakage problems are eliminated.

Although the preferred method of moving the wind turbine to the upper end of the tower is with a winch, it is possible that other means could be utilized. For example, some form of ratcheting mechanism could be utilized. A rack and pinion gear arrangement which is motor-driven could also be used.

Thus it can be seen that a novel apparatus has been provided for mounting a wind turbine on the upper end of a wind turbine tower involving the use of a carriage which is movably mounted on guide rails provided on the tower and wherein the need for an extremely large crane is eliminated. The relationship of the carriage 32 with respect to the guide rails 28 and 30 ensures that undesirable horizontal movement

1 between the carriage 32 and the guide rails 28 and 30 will be prevented while permitting  
the desirable vertical movement of the carriage 32 on the guide rails 28 and 30.

It can therefore be seen that a novel apparatus and method has been provided  
which accomplishes at least all of its stated objectives.

5

10

15

20

25